

# **MODULAR EXPANSION JOINT SYSTEM**

**March 13, 1995**

## **General Requirements**

### **1.01 Description**

- A. This item of work shall consist of furnishing material, services, labor, tools, equipment, and incidentals necessary to design, fabricate, inspect, test, and install the expansion joint system as specified.
- B. The expansion joint system consists of a modular, multiple seal joint that will allow movements as shown and noted in the Plans.
- C. The expansion joint system shall be as shown and noted in the Plans.
- D. The expansion joint system shall be continuous across the full width of the roadway and up into the traffic barriers as shown in the Plans.

### **1.02 Acceptable Manufacturers**

Only manufacturers who have successfully completed the fatigue testing as described in Section 3.05 of this Special Provision will be permitted to design and supply modular expansion joints. The following manufacturers are known to have completed fatigue testing in accordance with the requirements of this Special Provision:

- 1. The D.S. Brown Company  
P.O. Box 158  
300 E. Cherry Street  
North Baltimore, Ohio 45872-0158  
Tel. (419) 257-3561 Fax (419) 257-2200
- 2. Watson Bowman ACME Company  
95 Pineview Drive  
Amherst, New York 14228  
Tel. (716) 691-7566 Fax (716) 691-9239

### **1.03 Submittals**

- A. Within 10 days of contract award the Contractor shall submit the name of the expansion joint manufacturer to the Engineer. Once the name of the manufacturer is submitted to the Engineer, the Contractor shall not change the expansion joint manufacturer unless the manufacturer indicates that they cannot supply the expansion joint in accordance with the requirements of this Special Provision.

The expansion joint manufacturer shall have at least three years experience in designing and manufacturing modular expansion joints. The Contractor shall provide written certification of the manufacturer's experience. This certification shall include the bridge locations, governmental agency/owner, name, address, and telephone number of the owner's/agency's representative.

The shop plans and calculations shall be prepared, reviewed, and approved by a registered professional engineer and shall carry his/her signature and seal. The registered professional engineer shall be employed by the manufacturer.

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2 B. Shop plans  
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- 4 1. The Contractor shall submit details of the expansion joint system to be  
5 used together with installation and waterproofing plans to the Engineer  
6 for approval prior to fabrication of the joint. The shop plans shall be  
7 submitted in accordance with Section 6-03.3(7). These plans shall  
8 include but not be limited to the following:  
9
- 10 a. Plan, elevation, and section of the joint system for each  
11 movement rating and roadway width with dimensions and  
12 tolerances.
  - 13 b. Complete details of all components and sections including all  
14 materials incorporated into the expansion joint system.
  - 15 c. All ASTM, AASHTO, or other material designations.
  - 16 d. Method of installation including sequence, setting relative to  
17 temperature, anchorage during setting, installation details at  
18 curbs, and installation of seals.
  - 19 e. Corrosion protection system.
  - 20 f. Requirements for storage of joint system and details of  
21 temporary support of joint for shipping, handling, and job site  
22 storage.
  - 23 g. Design calculations for all structural elements including all  
24 springs, and bearings. The design calculations shall include  
25 fatigue design for all structural elements, connections, and  
26 splices. All welded splices shall be shown on the shop plans.
  - 27 h. Welding procedures shall be in accordance with the current  
28 AASHTO/AWS D1.5 Bridge Welding Code.
  - 29 i. Replacement of parts subject to wear shall be allowed for in the  
30 design. The Contractor shall submit for the Engineer's  
31 approval, a written maintenance and part replacement plan  
32 prepared by the joint manufacturer. This plan shall include a  
33 list of parts and instructions for maintenance inspection,  
34 acceptable wear tolerances, methods for determining wear,  
35 procedures for replacing worn parts, and procedures for  
36 replacing seals.
  - 37 j. Modification to blockout reinforcing steel to accommodate the  
38 expansion joint system.

39 C. Certificates of Compliance  
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- 41 1. At the time of shop plan submittal, the Contractor shall submit to the  
42 Engineer the following certifications for review and approval.  
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- 44 a. Manufacturer's certificate of compliance with the AISC Quality  
45 Certification Program, Category III, Major Steel Bridges.
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- b. Certification that welding inspection personnel are qualified and certified as welding inspectors under AWS QC1, Standard for Qualification and Certification of Welding Inspectors.
- c. Certification that personnel performing nondestructive testing (NDT) are qualified and certified as NDT Level II under the American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-1a.
- 2. The Contractor shall submit the following test reports, certificates, and samples for review, testing, and approval within four weeks of the shop plan approval.
  - a. Manufacturer's certificate of compliance for all polytetrafluorethylene (TFE) sheeting, TFE fabric, and elastomer.
  - b. Certified mill test reports for all steel and stainless steel in the expansion joint assemblies.
  - c. Certified test reports confirming that the springs and bearings meet the design load requirements.

#### 1.04 Shipping and Handling

- A. The expansion joint system shall be delivered to the job site and stored in accordance with the manufacturer's written requirements and as approved by the Engineer.
- B. Lifting locations, lifting mechanisms, and temperature setting devices shall be shown in the shop plans. Lifting mechanisms, temperature setting devices, and construction adjustment devices shall not be welded to the centerbeams or edge beams.
- C. Damage to the joint system during shipping or handling will be cause for rejection of the joint system.
- D. Damage to the corrosion protection system shall be repaired to the satisfaction of the Engineer.

### Material Specifications

#### 2.01 Structural Steel

- A. Structural steel shall conform to the requirements of AASHTO M 183, AASHTO M 223 Grade 50 or AASHTO M 222. Aluminum components shall not be used.

#### 2.02 Stainless Steel

- A. Stainless steel shall conform to ASTM A 240 Type 304.

#### 2.03 Polytetrafluorethylene (TFE)

- 1 A. TFE shall be 100% virgin teflon, woven TFE fabric, or dimpled TFE  
2 conforming to the requirements of Section 18.8.1, Division II - Construction,  
3 AASHTO Standard Specifications for Highway Bridges, 15th Edition and  
4 current interim Specifications.  
5

6 2.04 Expansion Joint Seals  
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8 The maximum size of the expansion joint strip seals shall be 80 millimeters. "Box"  
9 seals or seals utilizing double webs will not be acceptable. Seals shall be continuous  
10 and no splices will be permitted.  
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12 <u>Property</u>	13 <u>Test Method</u>	14 <u>Range of Values</u>
15 Hardness, 16 Durometer A	ASTM D2240	55 -70
17 Tensile Strength	ASTM D412	14 MPa minimum
18 Elongation at break	ASTM D412	250%
19 Compression Set, 20 at 72 hr. at 100°C	ASTM D395	40%

21 2.05 Bolts, Nuts, Washers  
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- 23 A. Bolts and other hardware shall conform to the requirements of AASHTO M  
24 164 Type 1 or 2 and shall be galvanized in accordance with AASHTO M 232  
25 and Section 9-06.5(3).  
26

27 2.06 Other Materials  
28

- 29 A. Other materials shall meet the requirements of the Standard Specifications  
30 and this Special Provision.  
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32 **Design Requirements**  
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34 3.01 General  
35

- 36 A. The expansion joint seals shall not protrude above the top of the joint. Split  
37 extrusions may be used at upturns at all curbs.  
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39 B. The elastomeric or urethane springs and bearings shall be designed so that  
40 they are removable and replaceable. The removal and reinstallation of the  
41 strip seal shall be easily accomplished from above the joint with a 30  
42 millimeter minimum gap width. These operations shall be capable of being  
43 done with a one lane partial closure of the roadway.  
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45 C. The expansion joint system shall be designed to be watertight.  
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47 D. The effect of vertical and horizontal rotations, and transverse movements  
48 shall be accounted for in the design.  
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51 3.02 Limit States Fatigue Wheel Loads  
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- 53 A. The centerbeams or transverse seal separation beams, including edge  
54 beams, support bars, bearings, and other structural elements shall be  
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designed for the simultaneous application of the vertical and horizontal limit states fatigue wheel load ranges shown below:

Limit States Fatigue Vertical Wheel Load Range (Normal to the Roadway Surface)	Limit States Fatigue Horizontal Wheel Load Range (Parallel to the Roadway Surface)
11.79 tonnes/wheel	8.63 tonnes/wheel

These limit states fatigue wheel load ranges include impact and shall be increased for the effect of roadway grades when the grade exceeds 4 percent. For roadway grades 4 percent or less, the loads shown can be used without modification.

Alternate wheel load ranges may be used providing that the absolute magnitude of the wheel load ranges (e.g. sum of positive and negative loads along the same axis) is not less than the total wheel load ranges shown above.

### 3.03 Application of Limit States Fatigue Wheel Load Ranges

- A. For the design of the centerbeams and edge beams, two vertical and horizontal load ranges described above shall be applied simultaneously, spaced 2 meters apart, and applied at the roadway surface as a rectangular patch loading. The rectangular patch shall have a 230 millimeter length in the direction of traffic and a 500 millimeter width perpendicular to the direction of traffic. When the roadway grade exceeds 4 percent, the additional horizontal component due to grade shall be added to the horizontal limit states fatigue wheel range described previously.

As shown below, the percentage of the loads applied to the centerbeams and edge beams is based on the midrange position of the seals and the width of the top flange of the centerbeams.

Width of Top Flange of Centerbeams or Edge Beams	Percentage
56 mm or less	40
80 mm	50
100 mm	60

### 3.04 Fatigue Limit States Design

- A. The expansion joint structural steel members, connections both welded and bolted, and steel components shall remain free of cracks after 100 million cycles, which represents the endurance limit. Fatigue testing is necessary to establish the limiting or allowable stress range,  $F_{sr \text{ test}}$ , at the endurance limit of 100 million cycles.

The fatigue limit states equation shown below shall be satisfied for all expansion joint steel structural members, connections both welded and bolted, and steel components.

$$(0.5)f_{sr \text{ calc}} \leq F_{sr \text{ test}} \quad \text{Fatigue Limit States Equation}$$

where

$f_{sr \text{ calc}}$  = calculated stress range based on the simultaneous application of two sets of vertical and horizontal limit states fatigue wheel ranges at 2 meters spacing.

$F_{sr \text{ test}}$  = allowable limit states fatigue stress range at the endurance limit of 100 million cycles.

### 3.05 Fatigue Testing

Constant amplitude fatigue testing shall be performed to determine  $F_{sr \text{ test}}$ , (the allowable limit states fatigue stress range at 100 million cycles) for all structural members, connections both welded and bolted, and components.

The allowable limit states fatigue stress range at 100 million cycles shall be based on a survival probability of 95 percent.

The test loadings shall be applied so that the vertical and horizontal loadings are applied simultaneously. Testing shall be performed so that the horizontal load is 20 percent of the vertical load.

Fatigue testing shall be done by an independent testing laboratory. The following individuals have indicated that they have the facilities to perform the fatigue testing.

- A. Prof. Ferdinand Tschemmernegg, Head  
Institute of Steel and Timber Structures  
Faculty of Civil Engineering and Architecture  
University of Innsbruck  
Technikerstrasse 13  
A-6020 Innsbruck  
Austria  
tel (0 512) 748-4360 FAX (0 512) 748-4363
- B. Prof. Charles W. Roeder  
Department of Civil Engineering  
233 More Hall FX10  
University of Washington  
Seattle, WA  
tel (206) 543-6199 FAX (206) 543-1543
- C. Dr. John W. Fisher  
ATLSS Research Center  
Lehigh University  
117 ATLSS Drive, H Building  
Bethlehem, PA 18015  
tel (215) 758-3535 FAX (215) 758-5553

## **Fabrication**

### 4.01 General

- A. The expansion joints shall be fabricated in accordance with the dimensions, shapes, designs, and details shown in the approved shop plans and in conformance with the Standard Specifications and the Special Provisions.
- B. All the expansion joints shall be fabricated by the same manufacturer.

- 1 C. Seal retainer clips, if welded to the seal separation or edge beams, shall be  
2 welded continuously on the top side and on the bottom side.

3  
4 4.02 TFE Sliding Surface

- 5  
6 A. The TFE shall be bonded under controlled conditions and in accordance with  
7 written instructions provided by the manufacturer of the TFE.  
8  
9 B. After completion of the bonding operation, the TFE surface shall be smooth  
10 and free from bubbles.

11  
12 4.03 Stainless Steel Sliding Surface

- 13  
14 A. The stainless steel sliding surface shall have a finish of 0.5 micrometers  
15 (RMS) or less.  
16  
17 B. The stainless steel sheet shall be seal welded all around to the steel backing  
18 plate by the tungsten-arc welding process in accordance with the current  
19 AWS specifications. The stainless steel sheet shall be clamped down to  
20 have full contact with the steel backing plate during welding. The welds shall  
21 not protrude beyond the sliding surface of the stainless steel.

22  
23 4.04 Corrosion Protection

- 24  
25 A. All steel surfaces, except the surfaces under stainless steel or those to be  
26 bonded to TFE or those in direct contact with the seal, shall be protected  
27 against corrosion by one of the following methods:  
28  
29 1. Zinc metallized in accordance with the Special Provision  
30 **METALLIC COATINGS**.  
31  
32 2. Hot-dip galvanized per AASHTO M 111.  
33  
34 3. Painted in accordance with the Special Provision **APPLICATION**  
35 **OF PAINT**. The color of the final coat shall be Washington Gray  
36 (revised). The surfaces embedded in concrete shall be painted only  
37 with a shop coat of inorganic zinc silicate paint.

38  
39 4.05 Installation

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41 A. To aid in assuring proper installation of each expansion joint system in the  
42 field, the Contractor shall have available at the job site, the services of a  
43 qualified installation technician who is a full time employee of the  
44 manufacturer of the expansion system to be installed in this project.  
45 Recommendations made by the expansion joint manufacturer's installation  
46 technician, on or off the job site, and approved by the Engineer shall be  
47 adhered to by the Contractor.

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49 The joint manufacturer's installation technician shall advise the Contractor  
50 and certify to the Engineer that the proper installation procedures were  
51 followed. All certifications to the Engineer shall be in writing, signed and  
52 dated by the manufacturer's installation technician.

- 53  
54 B. The modular expansion joint system shall be installed in strict accordance  
55 with the manufacturer's instructions as approved in Section 1.03 of this

Special Provision, and the advise of the manufacturer's installation technician. The permanently installed joint system shall match exactly the finished roadway profile and grades.

The expansion joint system shall be water tested after installation. Leaks shall be repaired to the satisfaction of the Engineer.

C. The Contractor shall take precautions to protect the joint systems from damage. Special care shall be exercised at all times to ensure protection of the expansion joint system. Prior to installation of the joint, the blockout and supporting system shall be protected from damage and construction traffic. After installation of the joint system, construction loads shall not be allowed on the joint. The Contractor will be required to bridge over each joint. The method of bridging over each joint shall be submitted to the Engineer for approval.

D. The modular expansion joint system shall be set to the proper width for the ambient temperature at the time of setting. This information is indicated in the Plans.

Any mechanical devices, supplied by the joint system manufacturer, used to set the joint system to the proper width will remain the property of the manufacturer. When no longer required, the devices shall be returned to the manufacturer.

E. All forms and debris that tend to interfere with the free action of the expansion joint system shall be removed.

#### 4.06 Watertightness

A. After each joint has been installed and completed, it shall be flooded for a minimum of one hour to a minimum depth of 75 millimeters. If leakage is observed, the joint system shall be repaired at the Contractor's expense. The repair procedure shall be prepared by the manufacturer and submitted to the Engineer for approval. After repairs are made, the joint shall be retested for leakage.

#### 4.07 Inspection

A. Three levels of inspection must be satisfied before the expansion joints are accepted. These are: Quality Control Inspection, Quality Assurance Inspection, and Final Inspection. The manufacturer shall provide for both Quality Control and Quality Assurance Inspection. The Contractor shall provide access for the Final Inspection. The three levels of inspection are described below:

##### 1. Quality Control Inspection

During the fabrication process of all major components, the manufacturer shall provide full time Quality Control Inspection to ensure that the materials and workmanship meet or exceed the minimum requirements of the contract. Quality Control Inspection shall be the responsibility of the manufacturer's quality control group which shall be independent of the fabrication group.

##### 2. Quality Assurance Inspection



Quality Assurance Inspection shall be performed by an Independent Inspection Agency provided by the manufacturer. The Independent Inspection Agency, the proposed Quality Assurance Inspection Program, and the forms to be used for the Quality Assurance Inspection Program shall be submitted to the Engineer for approval prior to the start of fabrication. Quality Assurance Inspection is not required to be full time inspection, but shall be done at all phases of the manufacturing process. The frequency of inspection shall be included in the Quality Assurance Inspection Program.

### 3. Final Inspection

Upon arrival at the job site and prior to installation, the expansion joints will be inspected by the Engineer. The Contractor shall provide an area for the Final Inspection of the expansion joints.

Immediately prior to installation, the joint system will be inspected by the Engineer, for proper alignment, and complete bond between the neoprene seals and the steel, and proper stud placement. There shall be no bends or kinks in the joint system steel (except as necessary to follow the roadway grades). There shall be no straightening of such bends or kinks. Any joint system exhibiting bends or kinks (other than those shown on the approved shop plans) shall be removed from the work site, and replaced by a new joint system, at the expense of the Contractor. Neoprene seals not fully bonded to the steel shall be fully bonded at the expense of the Contractor. Studs shall be inspected visually, and shall be given a light blow with a hammer. Any stud which does not have a complete end weld, or does not emit a ringing sound when struck a light blow with a hammer, shall be replaced. Studs located more than 25 millimeters, in any direction, from the location shown on the shop drawings, shall be carefully removed and a new stud placed in the proper location. All stud replacements shall be at the expense of the Contractor.

### 4.08 Acceptance

- A. The expansion joints must satisfy each of the three levels of inspection described in Section 4.07 of this Special Provision before they will be accepted. Expansion joints which fail any one of the three levels of inspection shall be replaced or repaired at no expense to the Contracting Agency to the satisfaction of the Engineer. Any proposed corrective procedure shall be submitted to the Engineer for approval before corrective work is begun.
- B. As outlined in Section 3.05 of this Special Provision, fatigue testing of all structural members, splices, connections, and components shall be performed. Any revised details or material substitutions developed after the initial fatigue testing shall be retested in accordance with Section 3.05 of this Special Provision.

It is the Contractor's responsibility to ensure that the manufacturers have completed fatigue testing in accordance with the requirements of Section 3.05 of this Special Provision for the joint supplied. Any additional costs and/or time delays incurred as a result of additional testing or delays in obtaining an acceptable expansion joint manufacturer shall be the Contractor's responsibility.

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**Payment**

5.01 The lump sum contract price for "Modular Expansion Joint System - Superstr." shall be full pay for all materials, labor, tools, equipment, design, testing, inspection, services, and incidentals necessary to furnish and install the expansion joint systems as specified.